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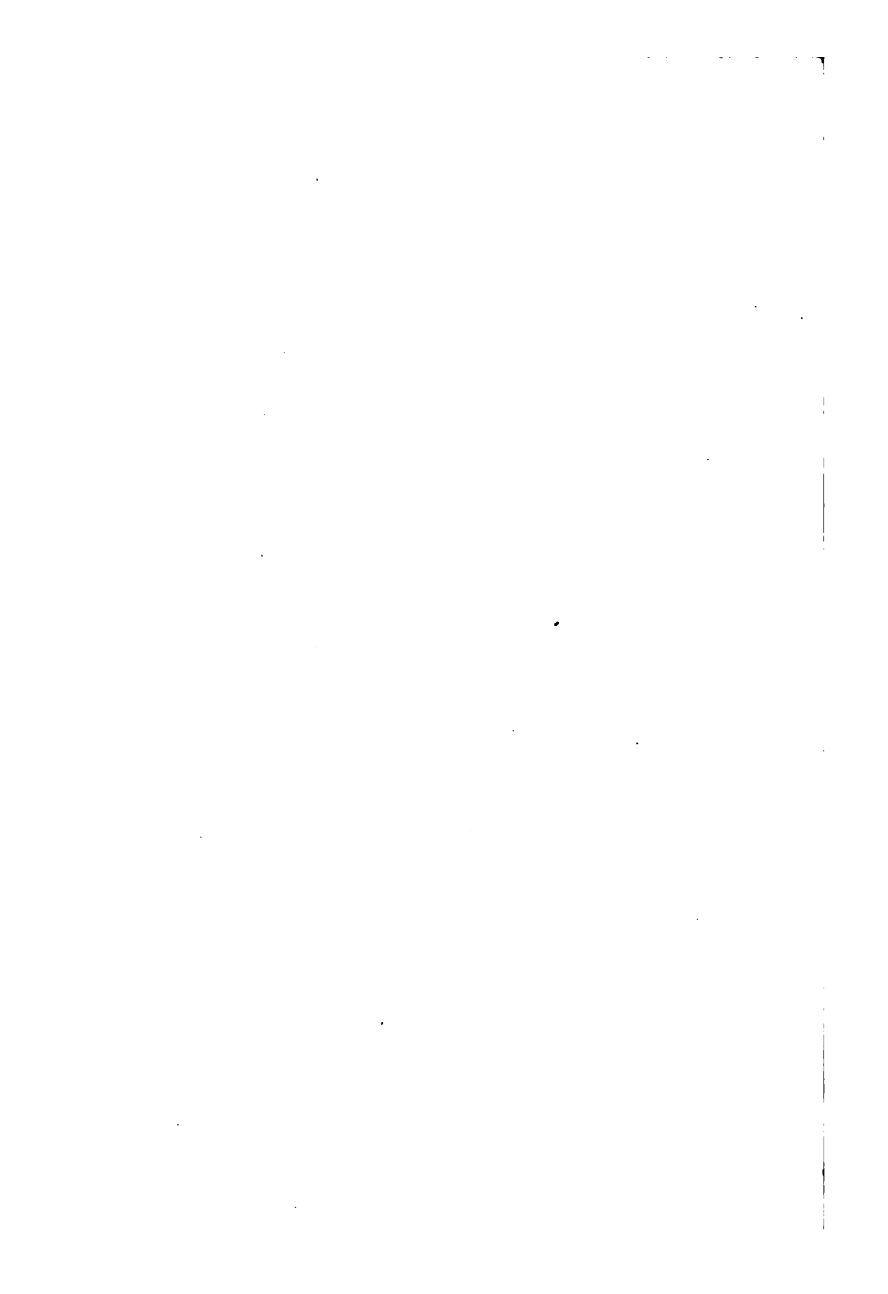
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INORGANIC
ANALYSIS.

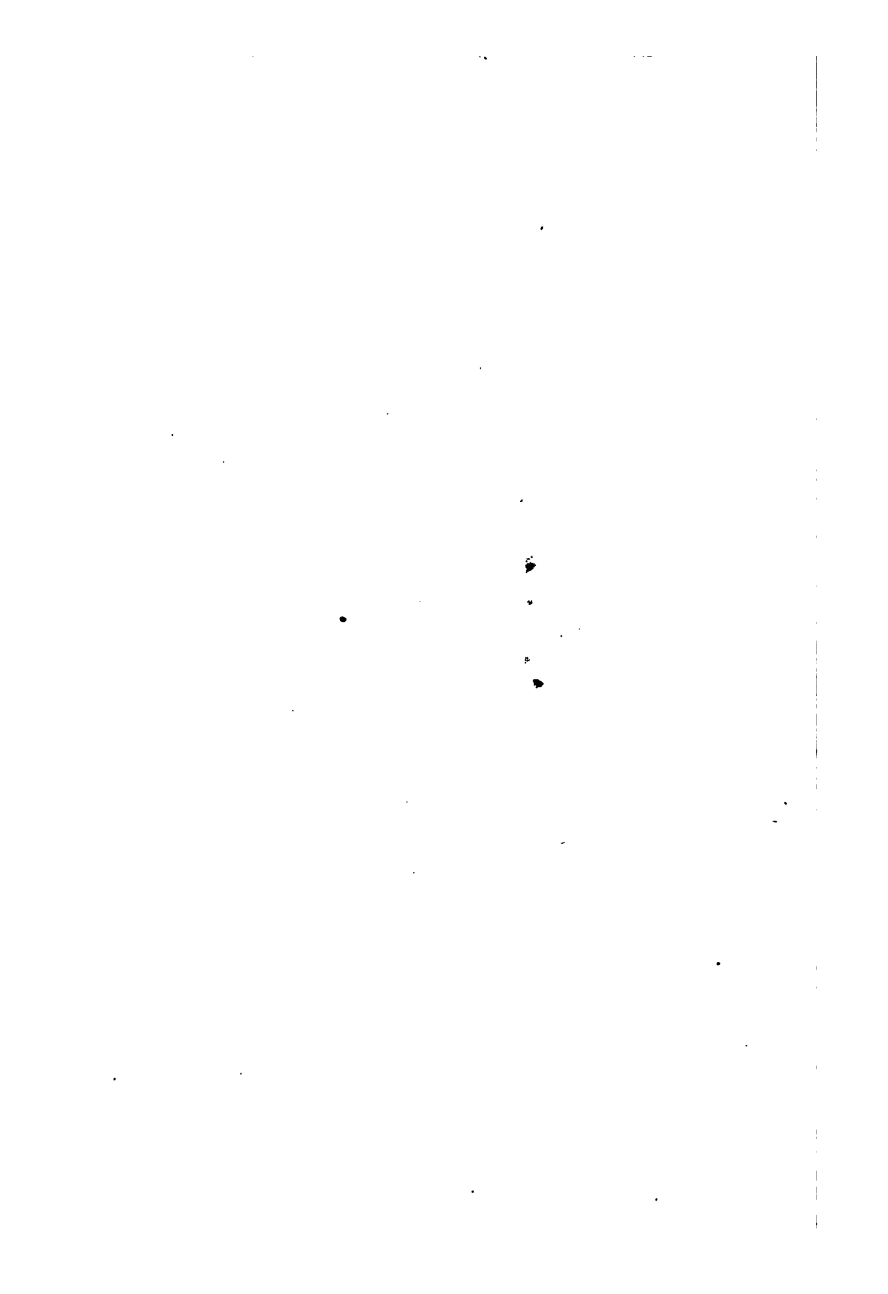
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QUALITATIVE ANALYSIS

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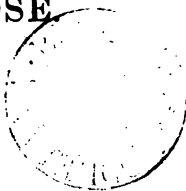
INORGANIC SUBSTANCES.

BY

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EPITOMIZED BY

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SHOULD the substance presented for analysis be in the solid state, it must be reduced to a fine powder in a mortar and then treated with distilled water. The aqueous solution having been concentrated by evaporation is to be acidified with muriatic, and treated as at page 5. The insoluble remainder is to be dissolved in muriatic, nitric or nitro-muriatic acids, and the solution having been filtered is to be treated as the aqueous solution had been. The insoluble substances generally are chromic acid, vanadic acid, selenic acid, permanganic acid, manganic acid, oxide of cerium, oxide of manganese and peroxide of manganese, peroxide of cobalt, peroxide of nickel, red and brown peroxide of lead, and other peroxides which seldom occur. The substances which remain insoluble in water and acids are to be fused; some with carbonate of potash or soda, and some with sulphate of potash, after which, being soluble in muriatic acid, they are treated as before.

Should the substance to be examined be a mineral or spa water, it will be found generally to contain potash, soda, ammonia, lithia, strontia, lime, magnesia, alumina, protoxide of manganese, protoxide of iron, oxide of zinc, oxide of copper. Acids,—sulphuric, sulphurous, nitric, carbonic, boracic, phosphoric, silica, besides chlorine, fluorine, bromine, iodine and sulphur united to a metal of the foregoing, together with some gases in solution, which are to be removed from the solution by boiling, and tested as at page 36.

If there be alkaline bicarbonates in solution without free carbonic acid, litmus paper is not reddened; but if it be reddened and be unaffected after boiling, free carbonic acid has been present.

A few drops of the mineral water is to be added to lime-water in a test-glass; a precipitate redissolving in an excess of the mineral water is a proof of free carbonic acid, and consequently it must contain alkaline bicarbonates, or the bicarbonates of lime and magnesia. If there be present the earthy bicarbonates (lime and magnesia), but no alkaline bicarbonates, or free carbonic acid, the precipitate does not redissolve in the mineral water.

If the mineral water has been taken from the vicinity of a town, a portion is to be evaporated, dissolved in water, and tested for nitrates by sulphate of protoxide of iron and concentrated sulphuric acid, which cause the solution to become dark brown; the colour disappears however after some time; but if a precipitate appears during the evaporation, there are no nitrates present.

To determine the presence of iodine and bromine, a portion of the solution must be evaporated nearly to dryness, and then treated with sp. wine. The spirituous solution having been evaporated cautiously to dryness is to be treated with a small quantity of water, and the aqueous solution tested for iodine or bromine.

If organic matter be present in the solution the water becomes yellow at the close of the evaporation, and the salt deposited becomes blackish on heating.

Colour of
the Sul-
phurets.

Note.—In the following pages the course of the analysis occupies the pages on the right-hand side, while the actions of the different substances towards reagents are contained in the left.

- Brown.** Platinum.—In the concentrated solution, a concentrated solution of chloride of potassium or muriate of ammonia gives a yellow. In the solution acidified with muriatic, potash-ammonia and their carbonates produce a yellow.
- Brown.** Iridium.—The above reagents give a black, but when both iridium and platinum are present, a reddish precipitate.
- Brown.** Molybdenum.—Sulphuret by blowpipe. Potash and ammonia produce a dark brown voluminous precipitate, insoluble in excess of the precipitant; carb. potash produces a yellow-brown, soluble in excess.
- Blackish.** Tellurium.—Often milky on dilution. Chloride of barium produces in the neutral solution a voluminous white precipitate, soluble in nitric and muriatic; potash-ammonia and their carbonates produce in tellurous acid a white precipitate, soluble in excess.
- Yellow.** Selenium.—Selenic acid produces a precipitate with a salt of barytes similar to sulphuric acid, from which it is distinguished by evolving chlorine when heated with muriatic. Selenious acid known by the red precipitate of selenium when it is heated with sulphurous acid. Heated with soda on charcoal in the inner flame or with salt of phosphorus, it is known by the smell of radish.
- Yellow.** Arsenic.—When heated with soda in the inner flame gives the odour of garlic; mixed with charcoal and boracic acid, and heated in a glass tube closed at one end, a metallic mirror of arsenic is deposited in the cold part of the tube. Arsenites distinguished from arseniates by nitrate of silver, producing in the one a brown, in the other a yellow precipitate; this latter distinguished from the precipitate produced in solutions of the phosphates by being easily soluble in weak acids.
- Black.** Gold.—Purple-red with proto-chlo.-tin, insoluble in mu-

BASES.—A.

Muriatic acid added to the solution of the salt concentrated.

There are precipitated—

Smell of chlorine when warmed,

Oxide of manganese, oxide of cerium, man-
ganic acid, vanadic acid, chromic acid, selenic
acid (these are partly deoxidated); also mu-
riates, subchlorides, with metallic chlorides;
also bromides and iodides; also

Tantalac acid, tungstic acid and titan acid.

The precipitate by mu-
riatic acid is not dis-
solved by muriatic or
nitric acid in these.
Tungsten distinguish-
ed by being easily so-
luble.

Sulphuretted hydrogen added to the
acidified solution,

There are precipitated—

Some of these fall as
oxides, depositing, af-
ter heating, a difficultly
filtered sulphur, as ox-
ide and acid manganic,
chromic acid.

Oxides of cadmium, lead, bismuth, copper,
silver, mercury, protoxide of mercury, oxide of
gold, proto and peroxides of tin, oxide of anti-
mony; also oxides of rhodium, iridium, osmium,
osmic acid, protoxide of palladium, oxide of
platinum, antimonious and antimonie acids,
oxide of molybdenum, molybdic acid, tellurous,
arsenious, arsenic and selenious acids.

Also subsulphurous,
sulphurous, chlorine,
bromine and iodine
acids.

The above precipitates treated with
ammonia + hydro-sulphuret of ammonia
and warmed.

There dissolve—

These can be re-precipitated by muriatic acid as sulphurets. The sulphurets when dissolved in acid are tested as on the other page.

Platinum, iridium, gold, tin, antimony, mo-
lybdenum, tellurium, selenium, arsenic, tung-
stic acid, vanadious and vanadic acids.

- Colour of the Sulphurets. riatric ; proto-sulphate-iron produces a blue colour with a brown precipitate. Oxalic acid produces a dark green colour ; soon the metallic gold subsides.
- Dark brown.* Tin (proto).—Solution milky ; v. dilute solution + solution of gold gives purple-red.
- Yellow.* Tin. (ox.) and Antimony distinguished by the colour of their sulphurets after reducing tin to the protoxide.
- Orange-red.* Antimony.—If antimony, tin and arsenic be present, the sulphurets are heated in a glass tube, by which sulphur and sulphuret of arsenic are sublimed. The sulphurets of tin and antimony are dissolved in concentrated muriatic and tested.
- Vanadious and vanadic acids.
- Yellow.* Tungsten.—Blowpipe. Zinc produces a blue colour in the acid solution ; distinguished from titan acid by the solubility of its alkaline compounds with water and their behaviour towards acids.
- Dark brown.* Vanadium.—Its compounds have a great resemblance to those of uranium, molybdenum, tungsten and chrome. Distinguished from chrome by the blowpipe ; the green pearl with borax or salt of phosphorus in the inner flame, changes into yellow in the outer, and becomes colourless on addition of vanadium. The alkaline vanadic solutions lose their colour when heated, while those of chrome retain it. Vanadic acid does not lose oxygen by heat, while chromic is changed thereby into oxide of chrome. Oxide of vanadium is green, soluble in water and alkalies, and is oxidated by heat ; oxide of chrome is green, insoluble in water and alkalies, and is not oxidated by heat. The acid solution of the yellow oxide of uranium is precipitated yellow by ammonia ; the precipitate changes not its colour by warming the solution, while the solution of vanadium becomes colourless by heat, and with muriate of ammonia gives a white powder. Prussiate of potash produces in solution of uranium a reddish-brown, in solution of vanadium a green precipitate. Solutions of molybdenum lose their blue colour when boiled with potash, and a dark brown oxide subsides ; but in the blue solution of vanadium alkalies produce a grey-white precipitate, and by addition of alkali in excess the solution becomes brown. Tungsten also has a blue solution, but is easily distinguished by the blowpipe.

OBSERVATIONS.

Colour of
the Sul-
phurets.

- Yellow.** Cadmium.—The sulphuret gives with soda on charcoal in the inner flame a brown-red. Potash, carb. potash and carb. ammonia produce in cadmium solutions white precipitates, insoluble in an excess of their precipitants. Ammonia produces in neutral solutions a white precipitate, soluble in excess of the precipitant.
- Black.** Lead.—A white precipitate with sulphuric acid, becoming black when moistened with hydro-sulph.-ammonia, yellow with iodide of potassium, soluble in great excess.
- Black.** Bismuth.—A portion having been evaporated in a platinum crucible to destroy part of the nitric acid a few drops of muriatic acid are added, and then water in excess gives a milkiness. The globules of reduced metal are brittle.
- Black.** Copper.—Blue colour with ammonia. Potash produces in solutions of deutoxide of copper a voluminous blue precipitate, which turns black when boiled with an excess of potash. Prussiate of potash produces a reddish-brown precipitate, insoluble in muriatic. A blade of a knife precipitates copper.
- Black.** Silver.—Muriatic acid gives a white precipitate insoluble in water, soluble in ammonia, which blackens on exposure to light. The blackened portion is insoluble in ammonia.
- Black.** Mercury.—The protoxide of mercury in solution is thrown down by the chlorides as a white precipitate, insoluble in acids; blackened by ammonia. In solutions of the peroxide, sulph. hydrogen produces a black precipitate, which becomes completely white when the mixture is shaken; it is insoluble in ammonia, but soluble in potash.
- Dark brown.** Palladium.—Prussiate of mercury gives a yellow-white gelatinous precipitate, becoming white on allowing the solution to stand, soluble in muriatic acid in excess; if the solution be very acid the precipitate does not appear at once; to distinguish it from the platinum precipitate it is heated to redness, whereby being reduced it is to be redissolved and tested.
- Brown.** Rhodium.—Insoluble in nitro-muriatic. Heated in platinum crucible with twice its weight of sulphate of potash is first a reddish mass; becomes yellow on increase of heat; solution in water yellow. Potash produces no precipitate; ammonia a yellow, soluble in muriatic.
- Brownish-low.** Osmium.—The solution heated with nitric acid gives a peculiar smell; when reduced by hydrogen to the metallic state and heated in the air gives the same smell.

**Sulphurets insoluble in hydro-sulph.-
ammonia are—**

When digested in nitric acid they may be distinguished as on the other page.

Cadmium, lead, bismuth, copper, silver, mercury, palladium, rhodium, osmium.

Note.—When the nitric acid is not strong, mercury, if present, is not dissolved; it may be known by its black colour and by subliming in tube; sulphate of lead may remain, but the greater part dissolves. The solution is previously filtered from sulphur.

**Colour of
the Sul-
phurets.**

Black. Cobalt.—Ammonia produces in cobalt solutions a blue precipitate; a large quantity renders the precipitate green, and when still more is added the precipitate mostly dissolves, forming a green solution and leaving only a very small green precipitate. The solution exposed to air becomes darker, and finally dark brown. If the cobalt solution contains muriate of ammonia, caustic ammonia produces no precipitate; the solution remains red, but after some time becomes brown, the change of colour commencing at the surface. Potash produces no precipitate in this, but if it contain no muriate of ammonia it produces a very slight precipitate; carb. potash produces a red precipitate, which, on being boiled, becomes blue; bicarb. a red; carb. ammonia a red in neutral solutions, soluble in muriate of ammonia; the solution has a red colour.

Black. Nickel.—Ammonia added in extremely small proportion to nickel solutions produces an inconsiderable green troubling, disappearing on addition of a larger quantity of ammonia. The solution has a blue colour, with tendency to violet. In the ammoniacal solution potash produces an apple-green precipitate; blowpipe. The carbonates of potash produce in nickel solutions apple-green precipitates; carb. ammonia produces the same in neutral solutions, soluble in excess, and forming a bluish-green solution.

Black. Protoxide iron.—Red prussiate of potash produces a dark blue precipitate, insoluble in acids. Potash-ammonia and their carbonates produce a white precipitate, which turns to grey and then green; at the point where it is in contact with air it becomes dark, and finally reddish-brown.

Black. Peroxide iron.—Prussiate of potash produces a dark blue precipitate, insoluble in muriatic. Potash-ammonia and their carbonates produce a reddish-brown voluminous precipitate, insoluble in an excess of the precipitant. Solution of galls gives a dark blue precipitate on the neutral solution, soluble in acids, and by addition of ammonia a dark red precipitate.

Alumina.—Potash produces in the neutral solution a bulky precipitate, soluble in excess, and in this latter muriate

B.

Nickel being partly soluble in hydro-sulph.-ammonia, gives sometimes a dark colour to the hydro-sulph.-ammonia solution.

The solution minus the precipitated sulphurets having been saturated with ammonia; hydro-sulph.-ammonia is added.

The precipitates are—

Protoxide and peroxide of iron, oxide of nickel, oxide of zinc, oxide of cobalt, protoxide of manganese, oxide of uranium, alumina.

The precipitate is filtered, moistened with water, to which a few drops of hydro-sulph.-ammonia is added, and then digested with dilute muriatic acid till it no longer smells of sulph.-hydrogen. The solution filtered and heated with nitric acid (not digested). The precipitate if not dissolved must be—

Distinguished by the blowpipe.

Sulphuret of nickel or cobalt.

The solution minus this precipitate saturated with ammonia may contain

Proto and peroxide of iron, alumina and uranium.

These will fall as precipitates, but must be redissolved in muriatic acid to be examined.

Colour of
the Sul-
phurets.

of ammonia produces a precipitate. Ammonia and the carbonates of potash and of ammonia produce a voluminous precipitate, insoluble in excess. Sulphuric acid produces no precipitate.

Brown. Uranium.—Potash and ammonia produce yellow precipitates, insoluble in excess of the precipitants; their carbonates produce yellow precipitates, soluble in the precipitants; in the protoxide of uranium the former produces a dark brown, the latter a dirty green precipitate. If the solution minus the ammonia precipitate be blue, it is nickel; if faintly rose-red, cobalt; the latter known by intense blue in both flames with boracic acid.

Black. Nickel.—Vide page 10.

Flesh-red. Protoxide of manganese.—Potash produces in the proto-salts a white precipitate, which in contact with air turns yellowish, brown, then black; ammonia produces the same effect in neutral solutions; the precipitate is soluble in muriate of ammonia, but the clear solution, if exposed to air, becomes brown, and deposits the insoluble brownish-black deutoxide. Carbonates of potash and of ammonia produce white precipitates, unaltered by exposure to air, and v. slightly soluble in muriate of ammonia. Potash, ammonia and their carbonates produce in the muriatic solution of deutoxide of manganese a dark brown voluminous precipitate; the precipitate is not prevented by the presence of muriate of ammonia.

White. Zinc.—Blowpipe. The sulphuret is entirely precipitated by hydro-sulphuret of ammonia, even from a strongly alkaline solution. Potash and ammonia produce a white gelatinous precipitate, soluble in an excess of the precipitant. Carb. potash produces a white precipitate, insoluble in excess, but soluble in potash and ammonia; muriate of ammonia prevents the precipitate from forming. Carb. ammonia produces a white precipitate, soluble in an excess of the precipitant.

Black. Cobalt.—Vide page 10.

Potash added to the ammoniacal solution.

The precipitates are—

Nickel and protoxide of manganese.

Hyd.-sulph.-ammonia added to the potash solution.

The precipitates are—

To be determined by the blowpipe.

Oxide of cobalt, oxide of zinc and protoxide of manganese.

b.

Hyd.-sulph.-ammonia is now to be added to a portion of the original solution neutralized by ammonia.

The following oxides are precipitated :—

Alumina, glucina, thorina, yttria, protoxide of cerium, oxide of zircon, titan acid, oxide of chrome, tantal acid.

These oxides do not appear with the sulphurets on supersaturating with ammonia, but on the addition of hyd.-sulph.-ammonia to the neutral solution fall as oxides with evolution of sulphuretted hydrogen.

Alumina.—If the alumina gives a blue colour with nitrate of cobalt, glucina is not present. Vide pages 10 and 12.

Glucina.—Potash produces a voluminous precipitate, soluble in excess of the precipitant; in the potash solution muriate of ammonia produces a precipitate. Ammonia produces the same precipitate, insoluble in excess. Carbonates of potash and of ammonia produce voluminous precipitates, soluble in great excess of their precipitants. No crystals of alum are produced by the addition of potash and sulphuric acid.

Thorina.—Potash and ammonia produce gelatinous precipitates, insoluble in excess of the precipitants; their carbonates produce precipitates, which dissolve in excess of their precipitants. Hydro-sulphuret of ammonia produces in neutral solutions a precipitate of hydrate of thorina. Thorina is insoluble in all acids but sulphuric after ignition; after fusion with pure or carbonate alkalies it still remains insoluble in muriatic or nitric.

Yttria.—Is distinguished from thorina by the double salt produced by sulphate of potash, which, if it contain thorina, is insoluble in a saturated solution of sulphate of potash, but soluble if it contain yttria. Potash-ammonia and their carbonates produce white voluminous precipitates; those of potash and ammonia are insoluble, while those of the carbonates are sparingly soluble in excess of their precipitants.

Cerium.—Distinguished from yttria and thorina by blow-pipe; and from yttria by its behaviour towards a solution of sulphate of potash. Potash and ammonia produce white voluminous precipitates, insoluble in excess. Carbonates of potash and ammonia produce white voluminous precipitates, slightly soluble in excess of their precipitants.

Zircon.—Distinguished from thorina and yttria by giving with a solution of sulphate of potash when heated a precipitate nearly insoluble in water and acids; from yttria by being rendered insoluble in muriatic acid by

Potash added to the solution of the oxides in nitric acid. Page 13.

Of the precipitates which appear are dissolved—

In the filtered solution zinc is precipitated by hyd.-sulph.-ammonia.

Oxide of zinc, alumina, glucina.

Muriate of ammonia added to the potash solution.

The precipitates are—

Alumina and glucina.

The insoluble precipitates by potash are digested in a solution of carbonate of ammonia, by which the following are dissolved, for which is often required a great quantity of carbonate of potash—

Thorina, yttria, protoxide of cerium, oxide of zircon.

ignition; from cerium by blowpipe, and by not acquiring a red colour on exposure to heat. Potash and ammonia produce voluminous precipitates, insoluble in excess of their precipitants; their carbonates produce voluminous precipitates, slightly soluble in great excess.

Titan acid.—Is determined, when cobalt and manganese are absent, by the blowpipe. By a difficultly filtered precipitate when the solution of the compound has been heated with an acid; also, it cannot be present in the acidified solution of the compound, since it will have been precipitated from the potash solution by an acid. Titan acid becomes yellow by heat; the colour disappears on cooling: when ignited it is insoluble in all acids except concentrated sulphuric; dissolves in fused carb. potash with effervescence; the salt is crystalline; it is insoluble in water but soluble in muriatic: in this solution a white voluminous precipitate is produced by potash-ammonia and their carbonates, insoluble in excess of their precipitants. In this solution tincture of galls gives an orange-red precipitate. Prussiate of potash produces in acid solutions a dark green precipitate. Metallic zinc produces in muriatic solutions of titanate of potash a blue colour; in this solution, (the zinc being removed,) potash or ammonia produces a blue precipitate, which by degrees becomes white. When to the solution of titan acid in muriatic tartaric is added, and afterwards ammonia, tincture of galls produces in this ammoniacal solution a dark green precipitate, which takes a long time to subside.

Chrome.—The precipitate by hydro-sulph.-ammonia is tested by the blowpipe. Neither oxalic acid nor either of the prussiates produce a precipitate in solutions of oxide of chrome. Oxide of chrome is of a green colour; it is insoluble in acids after ignition except sulphuric. Potash produces a light green precipitate, soluble in excess; if the solution is boiled the green oxide is reprecipitated, and the supernatant solution becomes colourless. Ammonia produces a greyish-blue precipitate, which appears violet by candlelight; the supernatant liquid has a reddish colour. Carb. potash produces a light green, which after some time becomes blue, and by candlelight violet, soluble in excess of the precipitant; bicarb. potash nearly the same; carb. of ammonia the same.

Tantal acid.—Vide page 28.

The insoluble precipitates by potash
which do not dissolve in a solution of
carbonate of ammonia—

Titan acid, chrome acid.

Lime.—Distinguished from solutions of alkaline salts in the same manner as solutions of barytic salts; it is distinguished from barytes by *hydrofluosilicic acid* producing no precipitate, and by dilute sulphuric acid and solutions of sulphates producing no precipitate in dilute solutions. In concentrated solutions sulphuric acid produces an immediate precipitate, not very soluble in dilute muriatic or nitric. When the solution of a salt of lime is mingled with so much organic matter as to be deeply coloured, the solution is mixed with a solution of superoxalate of potash, to which is added a little ammonia: should the solution be very acid it is neutralized by ammonia; should it be alkaline, by muriatic acid: by this means oxalate of lime is precipitated often with a very dark colour; the precipitate is dried and ignited; the resulting carb. lime is dissolved in muriatic, and the presence of lime is detected in the solution. When lime, or a salt of lime, is mingled with solid or pasty organic substances, the mass is treated with water acidulated with nitric, the solution is filtered, and the clear liquor tested for lime. When sulphate of lime is mingled with solid or pasty organic substances which cannot be dissolved in pure water, the mass must be treated in the same manner as if it contained sulphate of barytes. Solutions of potash and ammonia, carbonate and bicarbonate of potash, carb. ammonia and phosphate of soda, behave as with barytic and strontian solutions,

C.

The solution may contain magnesia, lime, strontian, barytes, lithia, soda, potash, ammonia.

The solution minus the hydro-sulph.-ammonia precipitates: supersaturated with muriatic acid and warmed till it no longer smells of sulphuretted hydrogen is to be filtered from sulphur. Carbonate of ammonia is added in excess to the filtered solution, and the solution is warmed till it no longer evolves carbonic acid gas.

The precipitates are—
Lime, strontian, barytes.

The precipitates are dissolved in muriatic acid. If when a few drops of sulphuric acid or sulphate of potash (dilute) are added, an *immediate* precipitate falls, there may be present—

But if after a long time there be a troubling, lime only is present.

Lime, strontian, barytes.

Dilute sulphuric acid is added to the dilute solution; it is warmed; the precipitate is filtered. To the filtered solution ammonia is added rather in excess, and to it oxalic acid.

If no precipitate falls, no lime is present.

If a white precipitate falls (at least after some time) it is lime.

The precipitate by sulphuric acid may contain barytes or strontian, or both, and also lime, if its presence has been determined in the filtered solution.

Another portion of the muriatic acid solution of the earth is tested with fluosilicic acid, which gives after some time a precipitate of barytes. To the solution filtered from this precipitate sulphate of potash is added; if a precipitate falls,

Solution of *oxalic acid*, or *binoxalate of potash*, produces even in very dilute neutral solutions a white precipitate, which, after some time, especially if ammonia be added to saturate the free acid, augments considerably in quantity; the precipitate dissolves in muriatic or nitric, but in acetic, even when concentrated, it is but slightly soluble. When alcohol is poured over the soluble calcareous salts and set on fire it burns with a red-coloured flame, similar to strontian.

Strontian.—Is distinguished from solutions of alkaline salts in the same manner as barytes; it is distinguished from barytes by hydrofluosilicic acid producing no precipitate, even after a long time, and also that, when chloride of strontian is heated on platinum wire in the inner flame, the whole flame acquires a strong carmine-red colour at the first moment; the presence of chloride of barium prevents the production of the carmine-red flame. Sulphate of strontian is not so insoluble in water as sulphate of barytes. Potash-ammonia, carb. and bicarb. potash, carb. ammonia, and phosphate of soda behave towards strontian solutions as towards barytic.

Oxalic or binoxalate of potash troubles neutral solutions; if they are very dilute the opalescence does not occur immediately; the precipitate is augmented on addition of ammonia. When strontian is mingled with much organic matter, the mixture must be treated in the same manner as a mixture of barytes and organic matter.

Barytes.—*Sulphuric acid* produces a white precipitate, insoluble in free acid; if it be present as sulphate of barytes, a portion of the substance is boiled with carb. potash or soda and filtered; the insoluble remainder treated with muriatic acid, the solution filtered and treated with dilute sulphuric. When the compound contains sulphate of barytes mingled with pasty or solid organic substances which are not soluble in water, the mass is cautiously heated in a crucible till the charcoal of the organic matter reduces the sulphate of barytes to sulphuret of barium; when cold it is boiled with water, the solution is decomposed by muriatic and tested by dilute sulphuric.

Carbonate of potash produces a white precipitate, which dissolves in free acids.

Carb. ammonia produces no precipitate.

Potash produces in concentrated solutions a voluminous precipitate, soluble on addition of water.

there was, besides barytes, strontian, which is present alone, or with lime, when fluosilicic acid has shown the absence of barytes.

Another Method.

To the solution in muriatic acid of the precipitates by carb. ammonia is added sulphate of lime ; if after some time there be no troubling, the precipitate contains lime ; if there be a precipitate, all three may be present ; if an immediate precipitate, barytes ; if after a long time, strontian.

Barytes.—Shown in the muriatic acid solution by hydro-fluosilicic acid.

The solution minus the fluosilicate of barytes ; which has been allowed time to deposit, or, if absent, the solution to which sulphuric acid is added, is evaporated to dryness ; the dry mass having been treated with water is left for some time and filtered ; if the filtered solution gives no precipitate with oxalate of potash or muriate of barytes, neither strontian nor lime is present.

When lime, strontian and barytes are precipitated by carbonate of ammonia, there can be present in the filtered solution lime, soda and potash (which can be the case when no precipitate appears in the muriatic acid solution on adding carbonate of ammonia). A portion of the solution filtered from the precipitated earths is evaporated in platinum, in such a manner as not to expel any alkaline metallic chlorides. If there be a deposit, phosphate of soda is added to the solution ; and if, after a while, there be a white precipitate, there may be

Magnesia, potash, soda.

Magnesia.—Known by phos. soda if present in the solution filtered from the carbonate earths. Another portion of the solution to which phos. soda has not been added (it being previously

Hydrofluosilicic acid produces, after a white, a crystalline precipitate, insoluble in free muriatic or nitric.

Neutral phosphate of soda produces a white precipitate, soluble in free muriatic or nitric acids.

Potash.—A spirituous solution of *chloride of platinum* produces in a solution of potash, or salt of potash, a bright yellow precipitate, not sensibly soluble in free acid; if the salt be soluble in sp. w. its solution therein should be tested. A concentrated solution of *tartaric acid* added in excess to a concentrated solution of potash, or its salts, produces immediately a crystalline precipitate of bitartrate; when the solution is dilute it appears, after some time, in the sparingly soluble salts as sulphate of potash; the precipitate does not appear for some time; by excess of a strong acid, as muriatic, ni-

ascertained whether this substance be present as muriates or nitrates, but no sulphuric acid present) is heated to dryness in a porcelain vessel, treated with water; the muriate of magnesia which had been partly decomposed and changed to magnesia is added to the other portion of the muriate of magnesia. The mass should be several times treated with water with a little carbonate of ammonia, in which the alkalies dissolve as chlorides, leaving magnesia. When the substances are united to sulphuric acid, the solution is evaporated and ignited to expel the ammoniacal salts; if nitric or muriatic acids had been present, sulphuric acid is added to the ignited mass and evaporated to dryness; dissolved in water; acetate of barytes added to precipitate the sulphuric; the filtered acetic solution is evaporated on platinum and ignited; treated with water there remains carbonate of barytes and carbonate of magnesia, or when the ignition is very strong, magnesia insoluble, while the alkalies dissolve as carbonates, or being changed by muriatic into muriates more easily dissolve.

Should magnesia not be present, and in consequence there be no precipitate, the other portion, to which no phosphate of soda had been added, is evaporated to dryness in a platinum capsule and heated to redness to expel the ammoniacal salts. A considerable portion is treated with a little water, chloride of platinum is added and then alcohol.

Potash gives a violet-colour to the outer flame by blowpipe; soda gives a yellow.

If there be a yellow precipitate it is potash; if there be none it is soda.

tric, or sulphuric, or oxalic, the precipitate is dissolved, but not by tartaric or acetic. Carbonate and caustic potash, soda and ammonia dissolve the precipitate, which is reproduced on addition of an acid.

Hydrofluosilicic acid produces a transparent gelatinous precipitate, insoluble in muriatic, but rendered by it opalescent; in the concentrated solution a white troubling is produced, and no play of colours.

Sulphate of alumina added to a concentrated solution, after it has been saturated by an acid, produces crystals of alum.

Carbazotic acid in alcohol produces in alcoholic solution of potash a bright yellow crystalline precipitate.

Blowpipe.—A bead of borax, in which oxide of nickel has been dissolved, is coloured blue by potash salts. When the salt is fused on a platinum wire at the point of the inner flame, the outer flame is coloured violet.

Soda.—No precipitates are produced by solutions of tartaric acid, chloride of platinum, or carbazotic acid (in the last case the solution must not be too concentrated). Sulphate of alumina added to the solution saturated with an acid produces no crystals of alum. Hydrofluosilicic acid produces in solutions which are not too dilute, a slight voluminous and opalescent precipitate.

Blowpipe.—When the bead is heated at the point of the inner flame the outer is coloured strongly yellow.

Magnesia.—In neutral solutions it is distinguished from solutions of alkaline salts by producing white precipitates with ammonia and with carbonate of potash; the solutions disappear on addition of muriate of ammonia; from barytes, strontian and lime, by ammonia, which produces in their solutions no precipitates. When the magnesian solutions are acid, they are distinguished from potash, soda and ammonia by a white precipitate with phos. soda, after having been supersaturated with ammonia; from lithia by a precipitate from potash in excess, particularly when the mixture is boiled; from barytes and strontian by affording no precipitate with dilute sulphuric; and from lime by oxalic acid producing no precipitate in neutral magnesian solutions. A mixture of magnesia, phosphate of soda and bicarbonate of ammonia deposits a salt on lines drawn on the evaporating glass.

When lime, strontian and barytes have been removed by carbonate of ammonia, there will be no precipitate of lithia if the solution of carbonate of ammonia be not too concentrated. If the filtered solution gives neither immediately nor after some time a precipitate, there is no lithia ; but if there be a precipitate, it is

Lithia, or magnesia, or both.

To distinguish between lithia and magnesia, another portion of the solution minus the precipitated earths, is evaporated and ignited to expel the ammoniacal salts, and then treated with water, whereby the magnesia dissolves. If the

Lithia.—Carb. soda produces at first no precipitate, but after some time an inconsiderable granular precipitate. Phosphates of soda produce no precipitate, but if ammonia be added to the mixture a strong precipitate is soon produced. Phos. potash produces no precipitate. Sulphate of potash with ammonia produces a strong precipitate by degrees. When the salt in solution is an alkaline salt, (known by carb. potash or soda producing no precipitate when added to a not very concentrated solution,) tartaric acid is added, and chloride of platinum; if there be no troubling there is no potash present. If a solution of phos. soda and ammonia produce after some time a strong precipitate, lithia is present.

The salt of lithia placed on platinum wire at the point of the inner flame; the outer flame acquires a carmine-red colour. Potash does not prevent the appearance of the red colour, while soda does, producing a yellow. The spirituous solutions of lithia burn with a carmine-red flame; those insoluble in sp. wine are pulverized, mixed with the sp. wine, and stirred while the spirit burns. The double salt of phosphate of soda and lithia fuses with soda on platinum; the fused mass is clear, but on cooling opaque and crystalline; if fused on charcoal it is absorbed. *Note.*—The earthy phosphates do not fuse with soda on platinum; if soda in excess is used the whole melts together, and the salt undissolved is seen in the fused mass; when the earthy phosphates are fused with soda on charcoal, the latter is absorbed, the former remains alone on its surface.

bases were not sulphates, sulphuric acid is added to the ignited precipitate, evaporated, ignited, dissolved in a small quantity of water. To the solution is added a solution of potash, which, in the neutral solution, is precipitated by the magnesia but not by the soda. If there be no precipitate,

Discovered in the filtered solution by alkaline phosphates.

Lithia only.

It is more difficult when these earths are present to determine the absence or presence of potash or soda,

If lithia be in the compound without magnesia, a portion of the filtered solution is evaporated to dryness and ignited. A portion of the ignited precipitate is dissolved in a small quantity of water, to which is added an alcoholic solution of chloride of platinum, to determine the presence of potash; another portion of the ignited mass is tested by the blowpipe for soda.

If magnesia is in the solution minus the precipitated earths; the bases are changed into sulphates, and the sulphuric acid is precipitated by acetate of barytes and treated as before.

A solution of chloride of platinum, or of sulphate of alumina, behaves towards a solution of ammonia as towards a solution of potash,

The presence of ammonia is discovered by heating the substance to be examined in a solution of caustic potash; an ammoniacal odour is produced, and if a glass rod moistened with muriatic acid is held over the solution, white vapours are formed.

Selenic acid.—Heated with muriatic acid, chlorine evolved and platinum dissolved; precipitate of salt of barytes insoluble; by blowpipe; converted into selenious acid by heating with muriatic.

Selenious acid.—Precipitated from acid solutions as a yellow sulphuret; dissolved in nitro-muriatic; nitric expelled by muriatic and precipitated by sulphite of ammonia, or if metals be present whose sulphurets would be precipitated, it is used in place of sulphite of ammonia.

Chromic acid.—In microcosmic salt an emerald-green colour in both inner and outer flame; if a chromate be pulverized with a chloride or bromide and heated with concentrated sulphuric acid, a red gas is disengaged; when chromates are heated with muriatic acid and alcohol they are reduced to oxide of chrome, the solution becoming dark green.

Chrome oxide.—By the green colour in the inner and outer flame with microcosmic salt; by a green-coloured solution unaltered by sulph.-hydrogen.

Manganic acid.—By the green colour of their salts and their changing by dilute acid into red peroxide, and by evolution of chlorine when they are heated with muriatic acid.

Manganese peroxide.—Intense purple-red of salts in solution and its behaviour towards blowpipe.

Tantal.—Insoluble in acids; potash solution gives a milk-white precipitate with muriatic; insol. in excess; a clear glass with salt of phosphorus distinguishes it from silica.

Wolfram.—With salt of phosphorus gives in the inner flame a blue colour, but when mixed with iron a blood-red; with borax a yellow or red; in the solution metallic zinc gives a blue colour; distinguished from titan and tantalic acids by its easy solubility in hyd.-sulph.-ammonia.

Titanic.—Falls from its solution on applying heat and is insoluble; zinc gives the solution a blue colour; with salt of phosphorus in the inner flame a blue colour.

Silica.—Insolubility in acids; in salt of phosphorus it swims in the pearl, scarcely dissolving; forms a clear glass with soda; dissolves in hydrofluoric acid with evolution of fluosilicic acid gas, which produces a precipitate in ammonia.

To determine the Acids.

The solution of the salt is heated with muriatic acid ; the following acids are deoxidated :—

Known by the smell of chlorine,

Selenic acid, chromic acid (when alcohol is added), and manganic.

There are also some acids precipitated by the addition of muriatic which are insoluble in water.

Tantallic, wolfram, titanic acids, and also silica.

Muriatic acid.—White fumes with ammonia; a yellow-green steam and smell of chlorine.

Sulphurous.—By its smell.

Nitric acid.—By heating the salt with charcoal in a porcelain capsule; by dissolving gold-leaf with muriatic; its salts give a yellow-red steam.

Nitrous.—By its orange colour.

Bromine.—By its hyacinth-red colour; the solution of the salt heated with sulphuric will colour the solution hyacinth-red.

Carbonic acid.—By inodorous effervescence; enough acid must be added to decompose any carbonate formed.

Oxalic acid.—By evolution of carbonic acid and carbonic oxide.

Chlorides.—Muriatic acid evolved from several, not from all, as chlo.-mercury, sub-chlo.-mercury, sub-chlo.-tin; chlo.-mercury dissolves and crystallizes out of the solution; sub-chlo.-mercury is changed by hot sulphuric to chloride, and sulphate of mercury with evolution of sulphurous acid; chlo.-tin deoxidizes the sulphuric acid; other unvolatile acids when concentrated act like sulphuric acid; when metallic chlorides are combined with neutral or bichromates of potash and heated in a retort with neutral or rather fuming sulphuric acid a blood-red solution distils (chromate of chloride of chrome), which with ammonia gives a yellow solution.

Bromides.—Are decomposed and the bromine known by colour and smell, except bromide of mercury, which should be heated with bisulphate of potash; if the metallic bromide be mixed with neutral or bichromate of potash, it will, when heated with concentrated sulphuric acid in glass tube, give, as the chloride before mentioned, a blood-red solution, which treated with ammonia is colourless.

Iodides.—Evolve a violet gas and sulphurous acid; the

The dry substance is treated with concentrated sulphuric acid, and if no effervescence take place, it is gently heated and the acid indicated by the smell; these acids are—

Muriatic, sulphurous, nitric, nitrous, bromine, carbonic and oxalic acid.

Concentrated sulphuric acid, when heated with the dry salt, decomposes several metallic compounds, such as—

Chlorides, bromides, iodides, fluorides, fluosilicates, fluoborates, sulphurets, sulphurous salt, unter-sulphuric and sulphurous, nitric and nitrous, chlorates and bromates, carbonates, oxalates and manganic acid.

metallic iodide mixed with superoxide of manganese and red or brown oxide of lead, and heated with sulphuric acid, iodine is evolved without sulphurous. In concentrated solutions a similar decomposition is effected by sulphuric acid, rendering the solution yellow in the cold, brown-red in the heat; when put to a bead of salt of phosphorus having oxide of copper in solution the flame becomes emerald-green; heated with manganese and sulphuric in a vessel in which a paper of blue starch is placed; battery with starch.

Fluorides.—Action on glass when heated with sulphuric acid; when in solution neutralized with ammonia, sulphuric acid is added and heated in platinum with waxed cover. The fluorides undecomposed by sulphuric acid are ignited with three or four times their weight of carbonate of soda, treated with water and filtered, oversaturated with muriatic acid, left standing till the carbonic acid has escaped and supersaturated with ammonia; chlo.-calcium added precipitates fluoride of calcium, which being filtered is treated with sulphuric acid; the fluoride mixed with salt of phosphorus and heated at one end of an open tube, so that a portion of the fluoride may play on it, there is action on the tube and Brazil wood paper is yellowed; or heated on platinum foil placed in a glass tube.

Fluosilicates.—Give fluosilicic acid and fluoric acid; the fluosilicates of lime and barytes should be heated with sulphuric acid in platinum to above 100° .

Fluoborates.—Give fluoboric and fluoric acids.

Sulphurets.—Partly sulph.-hydrogen, partly sulphurous acid.

Sulphurous salts.—Known by the smell of sulphurous when no sulphuretted hydrogen is set free.

Unter-sulphuric and sulphurous.—Mixed with a neutral salt of zinc and filtered from the sulphuret, muriatic acid added, the smell of sulphurous and the precipitate of sulphur.

Nitric and nitrous.—On charcoal when heated with copper and sulphur, an amalgam of zinc poured over it and a solution of a neutral chloride of iron; a small portion of the salt let fall through the solution of the mercury, a black spot appears after a little time where the nitrate lay; to the solution of the nitrate in sulphuric acid more than one-third is added; after heating there is added a concentrated solution of a protoxide of iron-salt as proto-sulphuret of iron; a dark brown-blue co-

lour strikes into the solution, which changes after some time.

Chlorates and bromates.—Heated in the dry state in retort give off oxygen ; distinguished by decomposing, by concentrated sulphuric acid and precipitation by nitrate of silver.

Carbonates.—Inodorous effervescence ; solution gives a precipitate with muriate of barytes ; muriatic acid and water added to the precipitates dissolve with effervescence, and do not appear again when the acid solution is saturated with ammonia.

Oxalates.—White insoluble precipitates with salts of lime.
Manganic.—Easily on being heated.

Metallic chlorides.—By salt of silver ; the white precipitate being insoluble in nitric acid is a better proof than the solubility in ammonia, as other white substances insoluble in ammonia may fall. The chloride of silver is soluble in a tolerably large quantity of very concentrated muriatic acid by heat, but on dilution it is precipitated.

Metallic bromides.—Nitrate of silver gives a white precipitate insoluble in dilute nitric acid.

Iodides and bromates.—Iodide of silver distinguished from chloride of silver by adding ammonia, filtering, and adding to the solution dilute nitric acid, oversaturating ; if there be a precipitate there was chlorine ; if very little, or rather an opalescence, none ; bromine distinguished from chlorine by a salt of lead, the bromide being soluble in much water, the chloride not.

Metallic fluorides.—As before.

Fluosilicates.—As before.

Fluoborates.—Action on glass and green colour to alcohol.

Sulphurets.—Evolution of sulphuretted hydrogen and the precipitate by chlo.-barium insoluble in nitric or muriatic.

Iodic acid.—As before.

Phosphorous and subphosphorous.—Chloride of mercury in excess gives a white precipitate insoluble in muriatic acid; if not in excess and when heated, metallic mercury falls.

Unter-phosphorous.—Heated with concentrated sulphuric acid, sulphurous acid is evolved and the acid is changed into phosphoric.

Silica.—Supersaturated with muriatic acid and evaporated to dryness.—Vide page 28.

Boracic.—The precipitate with chlo.-barium does not dissolve in muriatic; with sulphuric acid and alcohol gives a green-coloured flame.

Phosphoric.—When arsenic and boracic acid are absent, the concentrated solution being treated with a solution of chloride of barium or calcium, the precipitate dissolves in muriatic or nitric acid, and reappears on saturating with ammonia. If arsenic be present, it is removed by sulph.-hydrogen and phosphoric acid tested in the filtered solution by chloride of barium or calcium. If boracic acid be present, the precipitate by chlo.-barium or calcium does not dissolve in water nor in a small quantity of ammoniacal salts; when arsenic is removed (by nitrate of silver giving in the neutral alkaline phosphate a yellow precipitate, soluble in nitric and ammonia), acetate or nitrate of lead produces in an alkaline phosphate a white precipitate, which is insoluble in acetic acid, soluble in nitric acid; the precipitate heated in the outer flame crystallizes. Magnesia produces a precipitate in neutral alkaline phosphates when heated; if ammonia be added these precipitates are insoluble. Phosphates of ammonia and magnesia are insoluble in ammonia salts.

B.

When no volatile acid is expelled by sulphuric, there may be present—

Iodic, phosphoric, phosphorous, subphosphorous, boracic, silica.

Oxygen.—Colourless, has neither taste nor smell; refracts light feebly; heavier than air; sparingly absorbed by water; enlarges the flame of a taper, and relights it when blown out; produces a yellow-red vapour when mixed with binoxide of nitrogen.

Protoxide of nitrogen.—Rekindles glowing wood-shavings like oxygen; distinguished from oxygen by not forming with binoxide of nitrogen a yellow-red steam; it is not absorbed by a solution of nitrate of silver; it is soluble in its own bulk of recently boiled water; the solution has a sweet taste; soluble in alcohol, æther and oils.

Phosphoretted hydrogen.—Colourless; odour like garlic; water absorbs one-eighth its volume; inflames by contact with chlorine (when prepared by boiling phosphorus with water and a strong alkaline base); inflames by contact with atmospheric air, but when prepared by boiling a solution of phosphorous acid it does not light by contact with air, but burns when heated like the other gas with a strong white flame, which reddens moistened litmus, by which it is distinguished from many other gases; besides, it has a characteristic disagreeable smell; when passed through a glass tube of small dia-

Qualitative Analysis of Gases.

The gases likely to occur in analysis are—oxygen, both carburetted hydrogens, phosphoretted hydrogen, arsenuretted hydrogen, antimonuretted hydrogen, sulphuretted hydrogen, selenuretted hydrogen, telluretted hydrogen, carbonic oxide, nitrous oxide, protoxide of nitrogen, nitrogen, muriatic, hydrobromic, hydriodic, fluosilicic, fluoboric, prussic acid, ammonia, carbonic, sulphurous, chlorine, cyanogen.

The mixture of gases over mercury, or, if chlorine be present, over warm water, is treated first with a concentrated solution of caustic potash.

If they be not absorbed by the potash the gases are—

Oxygen, sulphuretted hydrogen, both carburetted hydrogens, phosphoretted hydrogen, arsenuretted hydrogen, antimonuretted hydrogen, hydrogen, carbonic oxide, binoxide of nitrogen, protoxide of nitrogen, nitrogen.

A portion of the gases is tested whether it burns when heated in the air; if so, the gases may be—

Carburetted, phosphoretted or arsenuretted hydrogen, or else carbonic oxide.

If this be not the case, but the gases increase the combustion of a burning body, there are present—

Oxygen or protoxide of nitrogen.

meter, heated at one place, it is decomposed, and the phosphorus settles near the heated spot; when agitated with a solution of nitrate of silver it will be absorbed, while the silver falls as a black precipitate. With a solution of chloride of mercury it will be entirely absorbed, with the formation of a yellow precipitate composed of chloride of mercury, phosphor. mercury and water. The phosphoretted hydrogen, which inflames spontaneously, always holds in mixture hydrogen, and consequently the absorption by nitrate of silver and chloride of mercury is not complete.

Arsenuretted hydrogen.—Colourless; odour like garlic; water absorbs one-fifth its volume; inflames by contact with chlorine; burns when lighted with a white flame, and forms when lighted in an inverted test-glass a dark brown stain, which, when heated, is known by its smell. It is distinguished from other gases, that when agitated with nitrate of silver it is absorbed, while silver is deposited as a black precipitate, and by chloride of mercury with the formation of a brown-yellow precipitate (chloride of mercury, arsenuretted mercury and water); there is always hydrogen present, which prevents the complete absorption. When a gas which contains very little arsenuretted hydrogen is conducted through a glass tube of small diameter, heated at one place, it is decomposed, and a mirror of metallic arsenic deposited not far from the heated spot, the smallest portion of which can be known by the smell.

Antimonuretted hydrogen.—Burns when lighted with a white flame, like arsenuretted hydrogen, and is decomposed when heated in a glass tube, depositing a dark mirror of metallic antimony, with nitrate of silver a dark precipitate, and with chloride of mercury a white precipitate remains long in suspension. It is distinguished from arsenuretted hydrogen by examining the metallic mirror; the arsenic dissolves in nitric, the antimony in nitro-muriatic.

Nitrogen.—Not combustible, and cannot support the combustion of inflammable bodies; inodorous; known by its negative qualities.

Binoxide of nitrogen.—Colourless; produces with air or oxygen a yellow-red steam, by which it is distinguished from other gases; absorbed by a solution of sulphate of proto-iron or other oxide of iron salt, and the solution will become of a deep olive or black colour.

Should the gas detonate when heated,
the gaseous mixture contains—

Oxygen, together with one or more of the
gaseous compounds of hydrogen.

If the gaseous mixture be not inflammable, nor be a supporter of combustion, it is principally, if not altogether,
Nitrogen and binoxide of nitrogen.

A portion of the gaseous mixture is to be agitated with nitrate of silver; if it be entirely or partly absorbed while a dark precipitate falls in the oxide of

Olefiant gas.—Burns with a bright flame, and when mixed with chlorine over water is absorbed, during which small drops of oil appear; the water takes an æthereal odour, and is not troubled by the addition of lime-water, nor absorbed by a solution of nitrate of silver.

Light Carb. hydrogen.—Burns with a weak blue flame, and when mixed with chlorine over water will not be decomposed in the dark but will in the light, and produces a troubling in the lime-water added, and be thereby absorbed as carbonate of lime. It will neither be absorbed in a solution of nitrate of silver, nor *when heated over mercury with potash.*

Carbonic oxide.—Burns with a blue flame, has no remarkable smell, and behaves towards a solution of nitrate of silver and towards chlorine over water like light carburetted hydrogen, by which it is distinguished by being absorbed by potash when heated with it over mercury.

Hydrogen.—Burns with a weak bluish flame; inodorous when pure; when mixed with an equal volume of chlorine over lime-water and exposed to daylight it forms muriatic acid, which unites with the lime, and does not produce a milky troubling. It is not absorbed by nitrate of silver, nor does it produce on it a black precipitate.

silver solution, the absorbed gas contains either—

The portion not absorbed is usually hydrogen mixed with these.

Phosphoretted, arsenuretted or antimonuretted hydrogen.

If the mixture be inflammable, and if there be no absorption with nitrate of silver, chlorine is added while the gaseous mixture stands over water.

If there be drops of oil, and the water have an æthereal smell, there is present

Carburetted hydrogen in maximum of carbon (olefiant gas).

If the gaseous mixture after being mixed with chlorine extinguishes flame, and with absorption produces a milkiness in lime-water, there are present—

Carburetted hydrogen in minimum (light carburetted hydrogen), or carbonic oxide.

When free hydrogen is still present, it is difficult to determine its presence.

If the inflammable gas, after the addition of chlorine over water, be absorbed after a longer or shorter time, but not produce a white precipitate on the addition of lime-water, the gas is—

Hydrogen.

If the mixture be not inflammable with air, but detonates with flame, bin-oxide of nitrogen is added; if there be a red steam thereby produced, and absorption in oxygen, there are present—

Oxygen gases.

If there remains a precipitate after the gaseous mixture has been treated

Distinguished by the inflammability of the latter, and separated by putting into the mixture about one-fourth its volume of alcohol, with which, when agitated, the protoxide of nitrogen is absorbed.

Selenuretted hydrogen.—Colourless gas ; smell resembling that of sulphuretted hydrogen ; rather more soluble in water than sulphuretted hydrogen ; the solution reddens litmus, and gives a brown stain to the skin ; is colourless, but soon becomes reddish on exposure to air from separated selenium ; the gas is decomposed by moist organic substances. Metallic selenurets have great resemblance to the sulphurets, distinguished by the smell of decayed radish when heated in the outer flame of the blowpipe ; heated in an open tube a part may be sublimed, while the remainder is oxidated. Selenious acid is deposited as a crystalline net-work in the cold part of the tube ; when mixed with a sulphuret the selenium often sublims alone, while the sulphur flies off as sulphurous. Sulphuret of arsenic will often sublime like selenium when treated with soda on charcoal ; the arsenic is known by the smell.

Telluretted hydrogen.—Smells like sulphuretted hydrogen ; reddens litmus ; dissolved by water ; the solution is colourless, but when exposed to air the tellurium separates with a brown colour ; the metallic tellurets are similar to the sulphurets ; heated in an open tube the tellurous acid sublims in the cold part of the tube as a white smoke, which when heated collects into drops. Oxide of antimony sublims as a white steam, and can be driven from place to place by heat ; both oxides distinguished on charcoal before the blowpipe, the oxide of antimony giving a blue or no colour to the flame, while tellurous acid gives it a beautiful green colour.

The precipitate redissolves in an acid with inodorous effervescence ; the gas extinguishes flame, and forms with lime-water a milky troubling.

Sulphuretted hydrogen.—Colourless gas ; smell of rotten eggs ; condensable by pressure into a liquid ; burns with a blue flame, evolving sulphurous acid gas ; explodes when mixed with air or oxygen. When in the dry state it is not altered by air or oxygen ; in the moist state,

with nitrate of silver, with chlorine, and then with oxygen, or binoxide of nitrogen, it may still contain—

Nitrogen or protoxide of nitrogen.

The Gases absorbed by Potash are—

Muriatic acid gas, hydrobromic, hydriodic, fluosilicic acid, fluoboric acid, prussic acid, ammonia, besides carbonic acid, sulphurous acid, chlorine, cyanogen, sulphuretted, selenuretted and telluretted hydrogen gases.

They are tested when in solution as in the foregoing part. Most of the gases absorbable by potash are acid. The strongly acid gases will, when in the dry state over mercury they are treated with borax, be absorbed, generally very slowly, as muriatic and sulphurous.

The weaker gases, as carbonic acid and sulphuretted hydrogen, are not absorbed.

When the gaseous mixture, previous to its treatment with potash, is treated with very little water, some gases dissolve in greater quantity, especially those which are soluble in potash.

A portion of the unabsorbed gases is treated with lime-water, by which the unabsorbed gases are dissolved; if there be a milky troubling there is present—

Carbonic acid.

A portion is treated with acetate of lead, and if there be a black precipitate, and the gas be entirely or only a portion absorbed, it shows the presence of

Sulphuretted hydrogen.

or in solution in water, it is decomposed. Concentrated sulphuric acid absorbs a portion of sulphuretted hydrogen; it forms sulphurous acid, and sulphur is deposited. Dilute sulphuric acid produces no effect upon sulphuretted hydrogen. Chlorine decomposes and changes it into muriatic, whilst sulphur is deposited. Bromine and iodine the same; fuming nitric acid decomposes it with deposition of sulphur.

Chlorine.—A yellowish-green-coloured gas; condensable by the pressure of four atmospheres into a bright yellow liquid; has a suffocating smell; supports the combustion of most bodies; heavier than atmospheric air; forms with a small quantity of water a crystalline bright yellow compound, which dissolves partially in a large quantity of water; recently boiled water absorbs twice its volume of the gas; the solution has the smell and bleaching property of chlorine; the solution is soon decomposed, and forms muriatic acid. Mercury and most metals absorb it, forming chlorides. Silver is precipitated as a dense white precipitate of chloride of silver, which darkens on exposure to light; absorbed by ammonia, with evolution of nitrogen.

Sulphurous.—Colourless gas, of a peculiar suffocating smell; does not support combustion; condensable by two atmospheres into a colourless liquid; soluble in water and in alcohol; the solution has the same peculiar suffocating odour of the gas; bleaches Brazil-wood paper; it is decomposed by exposure for a long time to the air, and converted into sulphuric acid. Solutions of sulphurous lose their smell when they have been boiled a long time, also when they are digested with peroxide of lead, the oxygen of which oxidates the acid, and sulphate of lead is formed. Nitric acid being put to a concentrated solution of sulphurous salt, sulphurous acid is evolved, and when strongly heated nitrous gas is evolved. Sulphuretted hydrogen produces in sulphurous solutions a milky-white precipitate of sulphur. To a solution of green manganate of potash is put sulphuric acid, by which it will be coloured strongly red; when a sulphurous salt or sulphurous acid is added the colour disappears. A solution of chloride of barium or calcium produces in the neutral sol. of sulphurous salts a white precipitate, soluble in dilute muriatic; in salts of lead it produces a precipitate, sol. in nitric acid when hot, but when boiled nitrous is evolved.

Selenuretted and telluretted hydrogen behave similarly, but the last portions have a different quality.

When the gas bleaches litmus, and is partly or entirely absorbed by mercury, it is—

Chlorine.

If the gas has the well-known smell of burning sulphur, and if it be absorbed by brown or red oxide of lead, by peroxide of manganese, as also by borax, it is—

Sulphurous acid.

A portion of the gaseous mixture is dissolved in potash, to which is added a solution of sulphate of protox. iron holding in solution a certain portion of

Cyanogen.—Colourless gas; peculiar pungent smell; compressible by 3·6 atmospheres into a colourless liquid; burns with a purple flame; soluble in alcohol; moderately soluble in water; the solution reddens litmus; sol. has the smell of the gas; not absorbed by mercury; solutions of the alkalies absorb it and form a brown solution. The metallic cyanurets form, like sulphur and fluorine, double compounds.

Fluosilicic acid.—Colourless gas, having an acid, suffocating smell, and fumes when in contact with air; extinguishes flame; does not corrode glass, but covers it when it is moist with silica, which adheres to the glass; not absorbed by dry oxides, but by dry metallic fluorides; sol. in water with deposition of gelatinous silica; by evaporation the acid is decomposed; fluosilicic is given off; fluoric acid remains; forms fluosilicates with metallic oxides; decomposed by concentrated sulphuric acid and heat.

Fluoboric acid.—Colourless gas; stronger smell than fluosilicic; extinguishes flame; does not act on glass; very soluble in water, with deposition of boracic acid as a white powder; the solution is very acid, and contains a mixture of fluoboric and fluoric acids; forms double salts with the oxides of the metals, mostly soluble in water. Fluoborate of potash difficult of solution; distinguished from fluosilicate of potash that ammonia separates silica from the latter; decomposed by sulphuric acid, but slower than fluosilicic.

Hydriodic acid.—A gas similar to muriatic and hydrobromic, easier decomposed than these by some metals, as mercury; very soluble in water, and the solution colourless; by heat hydriodic is evolved; the solution exposed to air is coloured first yellow, presently dark brown, then the hydrogen being oxidated by the air, the free iodine dissolves in the undecomposed acid; the metallic iodides distinguished from the chlorides and bromides by their insolubility in water; they have a characteristic colour.

oxide of iron ; the solution is rendered acid by the addition of sulphuric or muriatic ; if there be a blue precipitate it is—

It is better to put previously into the mixture red oxide of mercury to absorb prussic acid.

Cyanogen.

The gases more abundantly soluble in a small quantity of water are those which are absorbed by potash.

If the gas be decomposed with deposition of gelatinous silica, there is present—

Fluosilicic acid.

To the aqueous solution alcohol being added and ignited, if it burns with a green flame there is present—

Fluoboric acid.

If the solution of the gases in water, or better in potash, be mixed with nitric acid and starch, and this be coloured blue, there is present—

Hydriodic.

When to the gas, or to the solution of the same in water, chlorine or a solution of chlorine in water is added, and it is coloured brown thereby, and if the solution is further coloured when agi-

Hydrobromic.—Gas like muriatic; in contact with air forms a white steam denser than muriatic; decomposed by chlorine while brom. appears as a reddish steam, or when in quantity a precipitate of red drops; v. soluble in water; solution colourless; loses by boiling the brom. and hydrobromic acid, and the solution remains colourless.

Muriatic.—Colourless gas; condensible by pressure into a liquid; has a suffocating acid smell; fumes in the air; is not combustible; v. soluble in water; sol. colourless, fumes when exposed to air if it be concentrated; has an acid taste, and loses by heat the greater part of the acid, and when dilute loses none, but becomes concentrated; forms a white cloud when a glass rod moistened with ammonia is held over the solution; nitric decomposes muriatic, colouring the solution with free chlorine, by which it acquires the property of dissolving gold and platinum; not decomposed by sulphuric acid; when treated with peroxide manganese, red or brown oxide of lead, chlorine is evolved; muriatic acid produces in a salt of silver a white precipitate, which becomes dark violet by exposure to light, insoluble in dilute nitric, but soluble in ammonia.

Prussic acid.—Strong pungent odour like bitter almonds; taste acrid; poisonous; volatilizes rapidly; reddens litmus; salts of the oxides of silver, lead and barytes produce in the solution no precipitate. The alkaline and alkaline earthy metallic cyanuret will not be decomposed by heat when not mixed with excess of base. The compounds of cyanogen, with some metals, are decomposed at a high temperature; some when heated with access of air are changed into metallic carbonates, whilst nitrogen is evolved; others give off cyanogen and the metals, but most give off cyanogen and nitrogen, and leave behind a mixture of reguline metal and carbonate. Prussic acid is detected like cyanogen.

Ammonia.—Colourless; pungent odour; enlarges the flame of a taper, and tinges it of a pale yellow colour at the moment of being extinguished; condensible by pressure into a liquid; has a strong affinity for water; the salts are easily decomposed by heat.

tated with æther, whilst the æther becomes the colour of the same, there was present—

Hydrobromic acid.

Should the solution of the gases in water produce a white precipitate with nitrate of silver, insoluble in dilute nitric acid but soluble in ammonia, and has the absence of cyanogen and hydrobromic acid been determined, the gas contains—

Muriatic.

Should the solution of the gases in water indicate the presence of cyanogen gas when tested as the potash solution had been, and should a portion, or all, be absorbed by red oxide of mercury, the gas contains—

Prussic acid.

If, finally, a white cloud be formed in the gas when a concentrated solution of muriatic acid or muriatic gas is added to it, and a condensation be produced thereby, the gases contain

Ammonia.

It cannot exist in excess with the acid gases, and is known when in small quantity by the smell.

SYNOPTIC VIEW
OF
THE PRINCIPAL CHARACTERS
OF
THE EARTHS AND METALLIC OXIDES
BEFORE THE BLOWPIPE*.

*** ABBREVIATIONS.—O. F. *Oxidating Flame*. R. F. *Reducing Flame*. = parts; equal parts of the *Assay and Flux*. N. C. *Nitrate of Cobalt*. Fl. *Flaming*. C. under the column of either of the *Fluxes* means that the *Support* is *Charcoal*. P. F. *Platina Foil*. P. W. *Platina Wire*. A Brace { refers to the *Substances* in the *first Column* only, and includes all those which are contained in the space it comprehends.

* From Children's translation of Berzelius's 'Analysis by the Blowpipe.'

ASSAY.	HEATED ALONE ON		HEATED
	PLATINA.	CHARCOAL.	SODA.
1. ALKALIES.			
2. BARYTA.	2. Infusible.	2. Infusible.	2. } Fuse, and are a. } absorbed by the charcoal.
<i>a. Hydrate.</i>	<i>a.</i> Bubbles up and fuses.	<i>a.</i> Is absorbed.	
<i>b. Carbonate.</i>	<i>b.</i> Fuses readily into a clear glass; enamel-white on cooling.	<i>b.</i> Becomes caustic, and is absorbed.	<i>b.</i> }
3. STRONTIA.	3. Infusible.	3. Infusible.	3. No action on caustic strontia.
<i>a. Hydrate.</i>	<i>a.</i> Like baryta.		
<i>b. Carbonate.</i>	<i>b.</i> Fuses with moderate heat at the surface, great brilliancy; tinges strong R. F. red; becomes alkaline.		<i>b.</i> = parts, fuses into a clear glass, becomes milky on cooling; in strong heat, bubbles, and absorbed by the charcoal.
4. LIME.	4. No change.		4. { No sensible quantity dissol- a. { ved.
<i>a. Carbonate.</i>	<i>a.</i> Becomes caustic and alkaline; emits brilliant white light.		
5. MAGNESIA.	5. No change.	5. No change.	5. No action.
6. ALUMINA.	6. No change.	6. No change.	6. Swells up; forms an infusible compound.
7. GLUCINA.	7. No change.	7. No change.	7. No action.
8. YTTRIA.	8. Like glucina.	8. Like glucina.	8. Like glucina.
9. ZIRCONA.	9. Infusible; emits intense light.	9. Infusible; emits intense light.	9. Similar to glucina.
10. SILICA.	10. No change.	10. No change.	10. Fuses with brisk effervescence; clear glass.
11. MOLYBDIC ACID.	11. F. fumes and fuses; brown-yellow on cooling; in R. F. blue; intense heat, brown.	11. Fuses, and is absorbed and partly reduced.	11. P. W. effervesces, clear glass; becomes milky on cooling. C. fuses, absorbed and reduced.

WITH FLUXES.		WITH OTHER REAGENTS.	REMARKS.
BORAX.	SALT OF PHOSPHORUS.		
2. { Fuse readily with effervescence into a clear glass, which becomes opaque by Fl.	2. { As with borax, but foam and intumescence; end in a clear glass.	2. { N. C.; a globe of different shades of red: colour flies on cooling.	1. The <i>Alkalies</i> are not readily distinguishable by the blow pipe. <i>Lithia</i> leaves a dull yellow stain when heated to redness on platina foil. <i>Ammonia</i> may be known by heating the assay with soda: it gives off a pungent vapour, which turns the yellow colour of moistened turmeric paper brown.
a. {	a. {	a. {	
b. {	b. {	b. {	
3. {	3. {	3. {	
a. { Like <i>karyta</i> .	a. { Ditto.	a. { N. C. exhibits a black or greyish-black colour; does not fuse.	
b. {	b. {	b. {	
4. Clear glass; opaque by Fl.	4. Fuses in large quantity; clear glass.	4. { N. C. black or dark grey mass, infusible.	
a. Fuses with effervescence; with more carbonate clear glass; crystallises on cooling.	a. Fuses with effervescence.	a. {	
5. Like lime.	5. Fuses readily; clear glass; saturated with magnesia, opaque on cooling.	5. N. C.; flesh-colour when quite cold.	
6. Fuses slowly; permanently clear glass.	6. Permanently clear glass.	6. N. C.; fine blue glass, with strong heat when cold.	6. The blue colour is only distinctly seen by daylight.
7. Clear glass, with a large proportion of the assay; opaque by Fl.	7. As with borax.	7. N. C.; black or dark grey mass.	
8. Like glucina.	8. Like glucina.		
9. Like glucina.	9. Like glucina, but dissolves more difficultly.		10. The part not perfectly fused with nitrate of cobalt has a reddish-blue disagreeable colour.
10. Fuses very slowly; permanently clear glass.	10. Very small portion dissolves; clear glass.	10. N. C.; blue glass when perfectly fused.	
11. P. W. clear glass in O. F. C. and in R. F. glass becomes dirty-brown, but not opaque.	11. P. W. and in O. F. greenish glass while hot; colourless, cold. In R. F. becomes opaque; dull blue while hot, clear and fine green on cooling. C. same phenomena.		
			11. In the inclined glass tube, fuses, gives off vapour, which condenses partly on the tube as a white powder, partly on the assay in brilliant pale-yellow crystals.

ASSAY.	HEATED ALONE ON		HEATED
	PLATINA.	CHARCOAL.	SODA.
12. TUNGSTIC ACID.	12. R. F. blackens, but not reduced.	12. The same.	12. P. W. dark yellow glass, crystallizes on cooling; opaque white or yellowish. C. and R. F. reduced.
13. OXIDE OF CHROME.	13. No change.	13. The same.	13. P. W. and O. F. dark orange glass; opaque and yellow on cooling. R. F. opaque; glass green on cooling. C. absorbed but not reduced.
14. ANTIMONY.		14. Fuses readily; white fumes, which condense into pearly crystals.	
<i>a. Oxide of Antimony.</i>	<i>a. Fuses readily, and sublimes, in white fumes: precipitated oxide, burns like tinder into antimonious acid.</i>	<i>a. Fuses readily, and reduces; colours the flame greenish.</i>	<i>a. P. W. fuses; clear colourless glass becomes white on cooling. C. is reduced.</i>
<i>b. Antimonious Acid.</i>		<i>b. Does not fuse nor reduce; gives a bright light.</i>	
<i>c. Antimonic Acid.</i>		<i>c. Whitens; is changed to antimonious acid.</i>	
15. OXIDE OF TELLURIUM.	15. F. fuses and fumes.	15. Fuses, effervesces, and reduces.	15. P. W. colourless glass; white on cooling. C. reduced.
16. OXIDE OF COBALTUM.	16. No change.	16. The same.	16. Combines with effervescence, but not fused or reduced.

WITH FLUXES.		WITH OTHER REAGENTS.	REMARKS.
BORAX.	SALT OF PHOSPHORUS.		
12. P.W. and O.F. clear glass; not opaque by Fl. R.F. glass becomes yellow.	12. O.F. yellowish glass. R.F. fine blue glass.		12. If tungstic acid contain iron, the glass with salt of phosphorus is blood-red in R.F. Tin makes it green or blue.
13. C. fuses difficultly, glass emerald-green; on P.W. and O.F. the colour flies, and glass becomes brown-yellow; on cooling assumes a faint green tinge.	13. Green glass in both flames.		14. Antimony does not sublime at the fusing-point of glass. On charcoal, when red, ignition continues spontaneously. In a tube open at both ends it gives off white fumes.
a. C. dissolves in large quantity; glass yellowish, hot; almost colourless, cold. If saturated, part reduced and sublimed; strong R.F., the glass becomes opaque and greyish.	a. P.W. and O.F. glass, yellowish, hot; colour flies on cooling.		a. } The oxide and acids of antimony behave alike with the fluxes.
15. R.W. clear, colourless glass; white on cooling. C. becomes grey and opaque.	15. The same.		b. } c. }
16. Colourless, clear glass; becomes opaque by Fl.	16. Fuses easily; glass, permanently clear.		15. Metallic tellurium heated in a glass matrass, first gives off vapour, and then a grey metallic sublimate of tellurium. In a tube open at both ends emits abundant fumes which condense in a white fusible powder.

ASSAY.	HEATED ALONE ON		HEATED
	PLATINA.	CHARCOAL.	SODA.
17. OXIDE OF TITANIUM.	17. No change.	17. The same.	17. Fuses into a clear dark-yellow glass; white or grey-white on cooling, and crystallizes with evolution of great heat. C. not reducible.
18. OXIDES OF URANIUM.		18. Peroxide becomes protoxide; blackens, but does not fuse.	18. C. brown-yellow; not fused.
19. OXIDES OF CERIUM.	19. Protoxide becomes peroxide.	19. Peroxide does not alter.	19. C. not fused, soda absorbed; white or grey-white protoxide remains on the surface.
20. OXIDE OF MANGANESE.		20. Not fused; becomes brown in strong heat.	20. P. F. fuses; green glass, clear; cold, bluish-green. C. not reduced.
21. OXIDE OF ZINC.	21. Yellow white hot, white when cold; does not fuse, but gives out great light when very hot and white fumes, which condense like wool.		21. C. not fused, but reduced, with flame; white fumes, which cover the charcoal.
22. OXIDE OF CADMIUM.	22. F. no change.	22. Soon dissipates; leaves a red or orange-yellow powder on the charcoal.	22. P. W. not fused. C. reduced, sublimes, and leaves a circular yellowish mark.
23. OXIDE OF IRON.	23. O. F. no change.	23. R. F. blackens and becomes magnetic.	23. C. absorbed and reduced; not fused.
24. OXIDE OF COBALT.	24. No change.	24. The same.	24. P. W. pale red by transmitted light; grey, cold.
25. OXIDE OF NICKEL.	25. No change.	25. The same.	25. C. absorbed and reduced; not fused.

WITH FLUXES.		WITH OTHER REAGENTS.	REMARKS.
BORAX.	SALT OF PHOSPHORUS.		
17. P.W. fuses easily; glass colourless; becomes milk-white by Fl. R.F. glass assumes a dark amethyst colour, but transparent. In large quantity on C. and R.F.; glass dull yellow; when cold, deep blue.	17. O.F. clear, colourless glass. R. F. and on C. glass yellowish, hot; on cooling, first red, then very fine bluish-violet.	17. N. C. black, or greyish-black.	17. For the rest of the phenomena, see the text.
18. P.W. dark yellow glass; in R. F. becomes dirty-green.	18. P. W. and O. F. clear yellow glass; cold, straw-yellow, slightly green. C. and R. F. fine green glass.		
19. O. F. fine red, or deep orange-yellow glass; colour flies on cooling; cold, yellowish tint. Enamel-white by Fl. In R. F. loses its colour.	19. O. F. fine red glass; colourless when cold, and quite limpid.		
20. O. F. clear, amethyst colour glass; colour flies in R. F.	20. The same, but colour not so deep. In fusion in O. F. boils, and gives off gas; in R. F. fuses quietly.		20. A very minute portion of manganese gives a green glass with soda.
21. O. F. fuses easily, clear glass, becomes milky by Fl.	21. Nearly the same.		
22. P.W. yellowish glass, colour flies on cooling; on C. glass bubbles, cadmium reduced, sublimes, and leaves yellow oxide.	22. Dissolves in large quantity; clear glass; on cooling, milk white.		
23. O. F. dull red glass becomes clear and yellowish, or colourless by cooling. C. and R. F. bottle-green glass, or bluish-green.	23. Similar to borax.		23. The reduction of iron from the peroxide to protoxide is facilitated by tin.
24. Fuses readily, deep blue glass.	24. The same: the colour appears violet by candle-light.	24. With subcarbonate of potassa, black glass when cold.	
25. O. F. orange-yellow, or reddish glass; becomes yellow, or nearly colourless, on cooling.	25. As with borax, but the colour flies almost wholly on cooling.		

ASSAY.	HEATED ALONE ON		HEATED
	PLATINA.	CHARCOAL.	SODA.
26. BISMUTH.		26. Flies off in fumes, and leaves a mark with red or orange edges, which may be dissipated in R. F. without giving colour to the flame.	
<i>a. Oxide of Bismuth.</i>	<i>a. F. fuses readily, mass dark-brown, yellowish on cooling. In very intense heat reduces, and perforates the foil.</i>	<i>a. Instantly reduced.</i>	
27. OXIDES OF TIN.	27. Protoxide takes fire, and burns like tinder into peroxide.	27. R. F. peroxide does not fuse, but reduces in a strong prolonged heat.	27. P. W. effervesces, tumified, infusible mass. C. readily reduced.
28. OXIDE OF LEAD.	28. Minium becomes black while hot; at incipient redness changes to yellow oxide, fusible into orange-coloured glass.	28. Orange glass reduces into a globule of lead.	28. P. W. clear glass becomes yellowish and opaque on cooling. C. instantly reduced.
29. OXIDE OF COPPER.		29. O. F. black globule; flows over the charcoal; under surface reduces. R. F. reduces; with strong heat gives a bead of metal.	29. P. W. fine green glass, hot; on cooling, colourless and opaque. C. absorbed and reduced.
30. MERCURY.			
31. OXIDE OF SILVER.	31. Instantly reduced.	31. Instantly reduced.	
32. GOLD. 33. PLATINA. 34. IRIIDIUM. 35. RHODIUM. 36. PALLADIUM.	}		

WITH FLUXES.		WITH OTHER REAGENTS.	REMARKS.
BORAX.	SALT OF PHOSPHORUS.		
<i>a.</i> O. F. colourless glass. R. F. partly reduced, muddy greyish glass. 27. Fuses with great difficulty; permanently clear glass. 28. P. W. clear glass, yellow, hot; on cooling, colourless. C. flows over the surface and reduces. 29. O. F. fine green glass, which in R. F. becomes colourless, hot; but cinnabar-red and opake when solid. 31. O. F. glass becomes milky, or opaline, on cooling. R. F. greyish.	<i>a.</i> O. F. yellowish-brown glass, hot; colourless, but not quite clear, cold. R. F. clear and colourless glass, hot; opake and greyish-black, cold. 27. As with borax. 28. Clear colourless glass. 29. O. F. similar to borax; R. F. glass usually red, opake, and like an enamel. 31. O. F. yellowish glass viewed by transmitted light by day, by candle-light reddish. R. F. greyish.		26. In a glass matrass does not sublime at the fusing-point of glass. In an open tube scarcely gives off any fumes; the metal becomes covered with a dull brown fused oxide, of a slight yellowish tint when cold. 30. All the compounds of mercury are volatile; mixed with tin or iron filings, and heated in a glass tube, metallic mercury distils over. 32. These metals have no action on the fluxes, which can only serve to detect the foreign metals they may be combined with. They are best examined by cupellation with lead. 33. 34. 35. 36.

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